The work of compilation and checking the RMA Woolwich Book of Remembrance 1914–18 started in April 1962 and was based on the names carved into the memorial panels of the Royal Military Academy Chapel, now Woolwich Garrison Church. The additional details of date and place of death were obtained through the Commonwealth War Graves Commission, the India Office Library, the Royal Artillery Institution and the Institution of Royal Engineers. Details as to rank, awards and decoration have been checked in the Official Roll of Officers who Died in the Great War, His Majesty's Stationery Office 1920, Army Lists and, where necessary, Regimental and Corps records. The Roll has been compiled in the office of the Librarian, RMA Sandhurst. The Book was designed and written by Miss Elizabeth Friedlander between November 1965 and April 1967. The binding was designed and made by Mr Roger Powell, MA, ARCA.

The Argentine-Chile Frontier Case, 1965-7

MAJOR W. D. RUSHWORTH, BSc, RE

"BOUNDARY Commissions are not of frequent occurrence and the personnel employed on any one commission is very limited. Consequently the number of officers with experience of them is small and the lessons learnt are liable to be lost."[1]

As our colonial empire is scattered by the wind of change, the frequency of boundary commissions manned by British personnel becomes even less. This article records my personal experiences in connexion with a recent boundary settlement in the hope that they may be of general interest and of use to anyone faced with similar problems in the future. It is not intended to be a complete history of the case.

The settlement of international boundaries is a matter for diplomats, usually assisted by lawyers and geographers. However, to convert their decisions into a frontier, marked on the ground, they require the services of practical engineers and surveyors. The two stages are generally known as delimitation and demarcation. The stages overlap and the terms are frequently misused, but by defining them the overall process of creating a frontier becomes clearer. Delimitation means the choice of a boundary site and its definition in a treaty or other formal document.[2] Demarcation is the marking of the boundary on the ground and the description of that boundary by surveys and other methods. Royal Engineer officers have often been required to demarcate frontiers and at times have been called upon as advisers during delimitation.

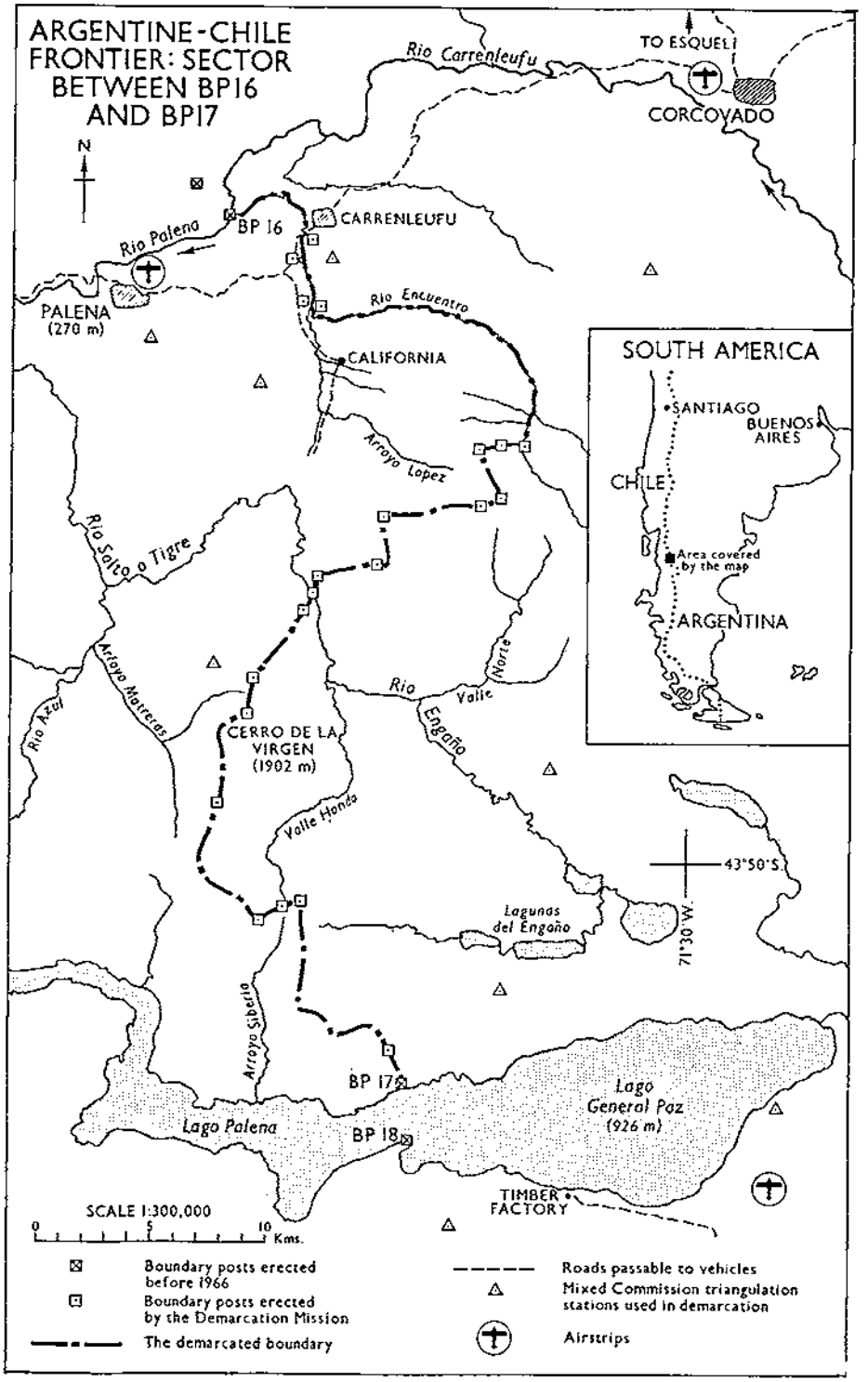
The Argentine-Chile Frontier Case differed from most boundary settlements in that a third country, Britain, acting as arbitrator, not only delimited, but also supervised the demarcation of the boundary in question. In the past, arbitration by a third neutral party was not unusual (e.g. by the King of Italy between Brazil and Britain on the British Guiana frontier), but demarcation was usually left to the two countries concerned. In future it will probably be less usual for a neutral country to act in this way, but it is probable that international organizations may be required to do this work and the experience gained in this case could be useful.

GEOGRAPHICAL BACKGROUND

The area that was in dispute lies in Patagonia between latitudes 43° and 44° South on the eastern slopes of the Andes (see map). The landscape is composed of numerous and mostly north-south mountain ranges and river valleys. The disputed area lies

[1] Clifford, Major E. H. M., RE, "Boundary Commissions", *RE Journal*, September 1937.

[2] Jones, Stephen B., "Boundary Making", p. 57.


ARGENTINE-CHILE FRONTIER: SECTOR BETWEEN BP16 AND BP17
N
Rio Carrenleufu
TO ESQUEL
CORCOVADO
Rio Palena
BP 16
CARRENLEUFU
PALENA (270 m)
Rio Encuentro
CALIFORNIA
Arroyo Lopez
Rio Salto o Tigre
Arroyo Matreras
Rio Azul
CERRO DE LA VIRGEN (1902 m)
Valle Hondo
Rio Valle Norte
Engaño
Lagunas del Engaño
43°50'S.
71°30'W.
Arroyo Siberio
BP 17
Lago Palena
BP 18
Lago General Paz (926 m)
TIMBER FACTORY
SCALE 1:300,000
0 5 10 Kms.
Boundary posts erected before 1966
Boundary posts erected by the Demarcation Mission
The demarcated boundary
Roads passable to vehicles
Mixed Commission triangulation stations used in demarcation
Airstrips
SOUTH AMERICA
SANTIAGO
BUENOS AIRES
CHILE
Area covered by the map
ARGENTINA

between two east-west gaps through the Andes, formed in the north by the Rio (River) Palena and in the south by Lago (Lake) General Paz. The mountains in this area rise to over 2,000 metres, the higher being permanently snow covered, while the forested valleys are unusually low, being generally at 200–500 metres. The area has a very heavy rainfall, with only a short and not very warm summer, but it is protected from the worst of the Pacific storms, so that the valleys in the northern half of the area have been settled, mainly by Chilean migrants. The southern half of the area is uninhabited, except for the occasional summer grazing of sheep. Large areas of valley forest have been burnt, principally to provide grazing, though some of the burning is attributed locally to the "English miners". This possibly refers to the activities of prospectors panning for gold at the end of the nineteenth century, who may have come from the nearby Welsh colony at Trevelin in Argentina. "These gigantic burnt, dead trees, mostly lie where they fell and they are strewn all over the valley floors, making only movement by horse possible. But there are many still standing, grey and stark on the green slopes of the cloud-wreathed mountains. They lend a melancholy air to the countryside".[3]

In summer the temperature in the valleys averages about 10°C, but on the mountains it is often below zero. Rain is frequent and heavy, and the wind in Patagonia is noted for its strength. Skies are generally covered by cloud, which is often well below the tops of the mountains. There are occasional short periods when the clouds disperse, the wind drops and the sun shines to reveal some of the most breathtakingly beautiful, unspoilt scenery imaginable.

HISTORICAL BACKGROUND[4]

The history of boundary negotiations between Argentina and Chile dates back to a Treaty between them in 1855 that the two countries should retain the territories they possessed in 1810, at the time of their separation from Spain. The Treaty also provided for the settlement of disputes by peaceful means and, in the event of disagreement, for their submission to the arbitration of a friendly nation. By a further Treaty of 1881 and later Protocols it was agreed that as far as 52° South the boundary should be the Cordillera of the Andes and it should follow "the line of the highest peaks which may divide the waters". Considerable progress was made in defining the boundary by the two countries, but no agreement could be reached about those parts where the line of the highest peaks did not coincide with the surface water parting. The situation was that "In the classical case of the Southern Andes, the swift west-flowing rivers spread their drainage areas by headward erosion to the eastern flank of the mountains. The problem was insoluble, by a literal interpretation, for the water-parting lay far to the east of the highest crests."[5]

Queen Victoria accepted the office of Arbiter in 1896 and in 1898 both countries submitted the dispute to her. Queen Victoria appointed an Arbitration Tribunal of three members, one of whom was Colonel Sir Thomas H. Holdich (late RE). The Secretary was Major S. C. N. Grant, RE, who was later transferred to South Africa during the Boer War and was replaced by Major E. H. Hills, RE. The Arbitration Tribunal worked with considerable speed and, after an extensive reconnaissance in the field, reported in 1902. Their report formed the basis for an Award by King Edward VII, who had succeeded Queen Victoria as Arbiter. The award contained a delimitation of the boundary, the part relating to the present case reading "Crossing the (River) Palena at this point, opposite the junction of the River Encuentro, (the boundary) shall then follow the Encuentro along the course of its western branch to its source on the western slopes of Cerro Virgen. Ascending to that peak, it shall then follow the local water-parting southwards to the northern shore of Lago General Paz. . . ."

[3] 1966 Award, p. 37.

[4] This paragraph is based upon Parts II, III and IV of the Report by the Court of Arbitration, December 1966.

[5] Jones, op. cit., pp. 99–100. This is an example of a bad delimitation, since it can not be demarcated as it stands.

Before the 1902 Award both countries had asked "the Arbitrator to appoint a Commission to fix on the ground the boundary" to be determined by the Award. Colonel Holdich was appointed as Demarcation Commissioner[6] and four British officers, Captain W. M. Thompson, RE, Captain C. L. Robertson, RE, Captain H. L. Crosthwait, RE, and Captain B. Dickson, RA, were allocated to the Commission. Included in Colonel Holdich's orders was the instruction that "The Duty of the British Officers is to superintend the alignment of the pillars. . . . Only in the case of very grave discrepancy between the mapping and the terms of the Award will it be necessary to appeal to the decision of the Commissioner. . . . Time is an all important consideration." There were discrepancies between the mapping and the topography in the area of the present case, but Captain Dickson, who was responsible for this sector, was not aware of them. In 1903 the area was little known, though both countries had carried out some exploration as part of the preparation of their case. Captain Dickson sited Boundary Post (BP) 17 on the north shore of Lago General Paz without difficulty, but the position of BP 16 at the junction of the Rio Encuentro with the Rio Palena was only settled after some doubt. The boundary between these two BPs was shown as agreeing with the Award on the 1902 Award map which was compiled from the maps submitted by the Parties. Between 1903 and 1907 the area was explored and it became obvious that no branch of the Encuentro reaches the Cerro de la Virgen, so that in this area the 1902 Award map was wrong and part of the 1902 Award was not capable of demarcation. It is not surprising that mistakes were made, for, to quote the Court of Arbitration in 1966, "it scarcely behoves this Court, with all the advantages of aerial survey at its disposal, to attribute any personal blame to these hardy pioneers. Apart from physical hardships, one of the greatest difficulties . . . was that of visibility".[7]

Throughout the following years the area in question was gradually opened up and small communities became established in some of the more fertile valleys. In 1941 the two countries established a Mixed Boundary Commission to demarcate the entire frontier. In 1943 the Commission first considered the area in question. A triangulation system was observed in the area between 1944 and 1947 and between 1951 and 1954 an air survey map was completed. However no agreement could be reached on the line of the boundary, so that in 1964 the British Government was requested to act as Arbitrator for that portion of the boundary between BPs 16 and 17.

THE COURT OF ARBITRATION

In March 1965 the British Government appointed a Court of Arbitration composed of

President: Lord McNair (formerly President of the International Court).
Members: Mr L. P. Kirwan, CMG (Director, Royal Geographical Society).
Brigadier K. M. Papworth, OBE, MC (late RE).

On 1 April 1965 an Agreement between the three countries settled that the Court was to work in accordance with international law, sit in London, and work in English. The Agreement also provided for any surveying required and for the execution, including demarcation, of the eventual Award. Both Parties accepted the Award as legally binding. In August 1965, after consultation with the Parties, the Court decided upon an area to be covered by aerial photography with a view to having a map of some part of that area made. After putting the contract out to tender, the British Government appointed Fairey Surveys Ltd to carry out the aerial photography and any subsequent mapping. In November 1965 I was appointed as Chief Technical Officer to the Court, with Staff-Sergeant M. G. Browning, RE, as my assistant. The Court also decided to establish a Field Mission, with Mr L. P. Kirwan

[6] A short account of the work of the Commission by Colonel Holdich is in the *Professional Papers of the Royal Engineers*, 1903, Vol XXIX.

[7] The conditions for exploring in Patagonia at that time can be discovered from Colonel Holdich's book *Countries of the King's Award.*

in charge, to visit the area. The only suitable time for field operations is the southern summer from December to March, so the advance party of the Field Mission left England on 5 December 1965 for South America.

THE FIELD MISSION

The work of the Field Mission was divided into three phases. The first phase, starting on 12 December 1965, was the provision of ground control for the aerial survey. The ground control available in the area to be photographed was some twenty stations of the Mixed Commission triangulation, which had been observed in 1944–7. If most of these could be found and pre-marked[8] they would be adequate, as Fairey Surveys intended to use APR (Airborne Profile Recorder) to supplement the existing control.[9] The operation was based on Palena, a small market town in Chile, close to the area. The work was carried out by myself and Staff-Sergeant Browning, ably assisted by three liaison officers from each party. Despite some difficulty with snow on the higher points, fourteen stations were marked by 2 January 1966, which was the earliest date that the survey aircraft was expected. All the points appeared clearly on the air photographs.

At a meeting with representatives of the two Parties in London in November 1965 I asked if helicopters could be made available. As a result we were very fortunate to be provided with three helicopters by the Parties. This was the first time they were used on this frontier. Without them the work could never have been completed in the time, as the only other method of movement is by horse. The points were marked in most cases by white crosses, each arm being 10 metres by 2 metres. Either the rock was cleaned, large stones were laid out, or fallen timber was arranged, and then painted white. Two locally engaged labourers were very bewildered when instructed to sweep snow off the top of the hills, so that they could be painted white. The liaison officers and the helicopter pilots from the two countries proved to be most delightful companions and a very good relationship was soon established. Everyone put maximum effort into the work, though it was suggested that rank distinction arose with the provision of a paint spray—only colonels were allowed to use it—majors and captains had to continue with brushes. Splashes of paint on uniforms were considered as honourable battle scars.

The second phase started with the arrival from the UK of the survey aircraft (a DC3) at Esquel, a frontier town in Argentina, with a good airport, on 13 January 1966. Under the direction of Brigadier Papworth, who arrived in South America on 7 January 1966, the Field Mission assisted the aircrew in liaison with the local officials and eventually approved the results of their work. In addition to two very experienced pilots the aircrew consisted of a photographer, electronics technician and flight engineer, so that they were reasonably self-sufficient, but the Field Mission and its liaison officers were happy to help the aircrew establish a record for beer consumption in Esquel's leading hotel. This opportunity arose as we waited impatiently for suitable photographic weather. Then from midday 24 January 1966 to midday 26 January 1966 there was the longest spell of clear skies during the whole of the Mission's visit and the photography was just completed in this time. The survey aircraft left Esquel on 3 February 1966, after the Mission had collected two sets of prints for use in the third phase and had satisfied itself that there was complete cover of a very high quality.

The third phase overlapped the second phase and started with the arrival in Palena of Mr Kirwan on 21 January 1966. The two members of the Court, based on Palena, wished to see the area in dispute in detail. They toured the area, accompanied by the liaison officers and experts, now six from each Party. These tours were mainly

[8] Pre-marking is the technique of marking the ground around a trigonometrical point before photography so that it appears clearly on an air photograph. This is much more accurate and reliable than taking the air photograph and identifying where the point falls by ground inspection. See the *American Manual of Photogrammetry*, Vol I, p. 365.

[9] The method by which the map was made, and the use made of the APR, is to be the subject of a paper to the Photogrammetric Society by Mr W. P. Smith of Fairey Surveys.

by the four helicopters now available, with landings for closer inspection, but trips were also undertaken in the two light aircraft provided by the Parties and by horse. During this period I acted as Secretary to the Mission, while Staff-Sergeant Browning worked with the survey aircraft, which was 150 kilometres away at Esquel at the end of very poor road and radio communications. Collection of topographic names for the map to be made of the area was difficult, as the two Parties frequently had different names for the same feature. Brigadier Papworth decided that for names' collection an outline, monochrome, sketch map should be made of the area, based on enlargements of existing maps, supplemented by detail from the air photographs. As soon as copies of the air photographs were received a team of liaison officers annotated them with major features and form lines. The photographs were then fitted under transparencies of the existing maps enlarged to the scale of the air photographs (supplied by the Military Geographic Institutes of Argentina and Chile) and the annotations were traced off. The result was compiled by myself or Staff-Sergeant Browning and then drawn on six sheets by two draughtsmen provided by the two Parties. The maps were reproduced in Santiago and proved useful as an interim map of the area. The Field Mission left South America between 11 and 14 February 1966.

THE 1966 AWARD

After the return of the Field Mission to England, Fairey Surveys prepared a 1/50,000 map of the area and the two Parties completed their cases for presentation to the Court. The Court sat for five weeks in September and October 1966. The proceedings were concerned with political and geographical arguments about the location of the frontier and are summarized in Part V of the Report by the Court. On 9 December 1966, Her Majesty Queen Elizabeth II made an Award based on the Court's report.[10] This included a delimitation of the disputed boundary, and appointed the Director of Military Survey as the authority responsible for carrying out the demarcation. With very good, complete air photograph cover, the Court were able to make a very accurate and detailed delimitation consisting of a written definition of the boundary and air photographs marked with key points. The Award required BPs to be erected at each of these key points ". . . or, if necessary in order to take account of geographical realities . . . within a distance of not more than 300 metres therefrom". Supplementary instructions by the British Government gave the requirements for additional BPs, ground completion of the 1/50,000 map, trigonometrical fixation of all BPs, and documentation of the boundary.

THE DEMARCATION MISSION

Preparations for demarcating the boundary were started well before the Award so that the whole case could be completed as quickly as possible. Arrangements were made with both Parties at a meeting in London in September 1966 for the required technical and administrative support. Most stores were provided in South America by the two Parties, but consignments from England were sent by sea in November 1966 and by air in December 1966. A thorough office reconnaissance of the area was performed, using the maps and air photographs, and the members of the Mission received training in the aspects of the task that differed from their normal work, such as concrete mixing, ground photography and typewriting. The Demarcation Mission consisted of myself as Officer in Charge, Staff-Sergeant M. G. Browning, RE (who was indispensable after his great success with the Field Mission) and Sergeant W. G. Anderson, RE. We left the UK on 1 January 1967 and flew, first to Santiago and then to Buenos Aires, for discussions with officials of both Parties. The Award aroused intense interest in both countries. The Award and the Demarcation Mission received very full press cover, almost entirely favourable. In both

[10] *Award of Her Majesty Queen Elizabeth II for the Arbitration of a Controversy between the Argentine Republic and the Republic of Chile*, published by HMSO, December 1966. The Report by the Court of Arbitration forms an integral part of the Award. The Award is normally referred to as the "1966 Award".

capitals the Mission was received by the respective Foreign Ministers, both of whom expressed their satisfaction with the Award and their thanks to the British Government for acting as Arbitrator. In both countries there was, very justifiably, a feeling that they were setting an example to the world in the peaceful settlement of an international dispute.

On 8 January 1967 the Demarcation Mission arrived at Palena, which was to be the main base of operations. The flight from Buenos Aires in an Argentine Air Force plane was comfortable and uneventful, but we discovered later that some alarm had been caused by the Buenos Aires papers carrying a story that our plane had made a forced landing well off course. At Palena we met the various personnel that had been agreed at the September 1966 meeting in London and saw the transport and technical and administrative stores that had been provided. The agreed personnel from each Party were a Liaison Officer representing his country (Senor Nestor Martinez from Argentina and Commandante Arturo Ayala from Chile), an Assistant LO, a Chief Technical Officer, a computer, two trigonometrical surveyors and three topographers. In addition there were light aircraft and helicopter pilots and groundcrews, drivers, cooks, orderlies, a draughtsman, a photographer and locally employed labourers. The operation functioned excellently without a single clerk. The transport provided by each Party was two helicopters, one light aircraft, two landrovers or equivalent, sixteen horses and a boat. The stores included all normal camping and surveying equipment and one set of Wild Distomat DL50 and one set of Tellurometer MRA3 Electronic Distance Measuring (EDM) equipment. Dark-room and drawing-office equipment were also provided.

Work started on 9 January 1967 with a reconnaissance of the northern part of the boundary, first by helicopter and then on horseback. The horse is the normal method of transport in the mountain areas. It is used by all ages and both sexes for any journey, whether to call on a neighbour, go to school, or visit the next town two days' ride away. The only roads suitable for motor vehicles are those connecting the main settlements, so that horses, or ox-carts for heavy loads, are the only means of moving around. All South Americans seem to be born horsemen and it was impressive to see how skilled riders negotiated the very steep broken country, and at the same time could study their surroundings and discuss a plan. The British contingent, on the other hand, found that their horses required full attention and for a satisfactory study of the ground it was necessary to dismount. For this reason, and because of the generous allotment of helicopters, the considerable potential of the horses was not fully exploited by the Mission. One Luddite horse had its revenge, by kicking a helicopter and putting it out of action for two weeks.

The helicopters were the mainstay of the Mission. At full strength we had four helicopters, two Hiller SL4 (three-passenger) provided by the Chilean Air Force and one Hiller SL4 and one Hiller 12E (two-passenger) provided by Argentina. Much of Argentina is level pampas, but all of Chile is close to the Andes, so that the Chilean pilots were much more experienced in mountain flying. In fact, the Argentine Hiller 12E could only be used in the valleys, because its carburettor was not heated and it lacked the power to overcome the strong winds at greater altitudes. Because of the strong turbulent winds, sudden mists, snow on the high ground and lack of emergency landing places in the wooded valleys, helicopter flying in Patagonia presents many special problems. We relied heavily on the advice of the senior pilot, Commandante Vicente Rodriguez (Chile), who was a superb helicopter pilot with an excellent topographic memory and who organized all the air effort. Although weather conditions frequently prevented the use of helicopters, when they could be used it made rapid access to all parts of the area possible, whereas any form of ground movement was very slow. The view from the helicopters rendered reconnaissance and perambulation of the boundary easy. Frequent supervisory visits were possible to all working parties and the heavy iron boundary posts, cement, sand and water were lifted to the mountain-tops. All the pilots showed great skill and ingenuity in landing on difficult sites in order to reduce the distance that stores had to be carried.

Generally the helicopters operated to a timed programme which was arranged at the daily evening meeting, but during the spells of good weather the demand for helicopter services exceeded the supply, so that priorities and tight control were necessary. On busy days each helicopter flew over five hours. A total of over 200 hours were flown during the Mission.

Politically, and because of the short and uncertain summer, it was desirable that the task should be completed, and the Mission leave the area, as quickly as possible. In a normal survey operation there would have been a gradual build-up of strength so that various stages of the task could proceed in due order, but this would have been difficult to organize from England and could have led to the task being incomplete at the end of the season. Thus it was essential to start all the tasks as soon as possible in order to deploy the large staffs available and finish quickly. Reconnaissance was always only one, or less, jump ahead of the work and ways had to be devised to enable as many tasks as possible to proceed simultaneously. We were fortunate to have a guide to procedure in the Regulations of the Argentine-Chile Mixed Boundary Commission. While some of these Regulations were not applicable and others were out of date (there was no provision for EDM, for example), in general they formed the basis of our method of working and the records we kept. This has ensured that the demarcation of this sector of the boundary is reasonably consistent with the remainder, which is important, because the Mixed Commission is responsible for the maintenance of the BPs and documentation for the whole frontier. Technical Instructions, which included relevant extracts from the Mixed Commission Regulations, were issued by the Mission before leaving England.

I selected the sites for the twenty-one BPs erected by the Mission, assisted by a senior representative from each Party, at the same time reconnoitring a triangulation and traverse scheme. The erection of each BP was allotted to one or other Party. The BPs are angle-iron pylons about 2 metres high, set in concrete, surmounted by a cast-iron plaque with the names of the two countries on opposite sides. This is the standard Mixed Commission design which is the same as that used by Colonel Holdich. Staff-Sergeant Browning supervised the erection of the first BP by each Party, especially ensuring a high standard of concrete. One local labourer took this to heart when told to get a box of aggregate "like this stone" from a near-by stream. He was seen, some time later, sitting by the stream with the specimen stone in one hand, picking up one stone at a time and only accepting it if it corresponded in size and shape with the specimen. After the first BPs, checks were only made after erection, to ensure that the BPs were properly constructed with all members present, nuts tight, name plates properly oriented and witness marks in position. One BP was not inspected by any Mission member. This was erected on the pinnacle of the Cerro de la Virgen by a lieutenant and a sergeant of an Argentine Mountain Regiment. They carried the BP and cement up the mountain, the last part of which they classed as a fourth-degree climb. They then erected the BP on the only flat space available—barely leaving room for themselves to stand. This was thought to be the first time a BP has been erected on the peak of a mountain in the Andes. After the erection of each BP Staff-Sergeant Browning prepared a detailed description of its surroundings and access routes, marked its location on an air photograph and supervised the taking of ground and helicopter photographs of the BP and panoramic photographs from it. These descriptions were fair drawn by the draughtsman, so that copies, and prints of the photographs, were available to both Parties before the Mission left South America.

The positions of the BPs were determined trigonometrically in relation to the existing Mixed Commission traingulation to third-order accuracy in accordance with the Mission's Technical Instructions. This work was mainly achieved by EDM traverses, but four triangles were measured by classical methods. In order that the trigonometrical work could be completed quickly, stations were sited as far as possible on low ground, so that observations could take place in poor weather, and where helicopters could land. Such sites are more suitable for traverses than triangulation,

so that the use of EDM traverses in place of triangulation speeded the work considerably. Sergeant Anderson was in charge of the start of the field work, but it soon became apparent that he would be required full time for computing. Fortunately one of the LOs, Major Ricardo Cepeda (Chile), was very experienced in this work and took charge of it. The work was done by two observing pairs, each made up of one surveyor from each Party. Eight stations of the Mixed Commission triangulation were occupied, two permanent and nine temporary trigonometrical stations were erected, satellite stations close to twenty BPs were occupied, and one BP was intersected. Temporary satellites were used at BPs so that observing and erection could proceed in either order, or simultaneously. Measurements from the satellite to the BP were made after the BP was erected. All observations were performed by day. Wild T2 theodolites and expendable wooden signals were used for angular measurement. One of the theodolites was graduated centesimally instead of sexagesimally. Both British observers found that, once they had got used to it, this instrument was very easy to read, simple to book and the least unit of 0.0001 centisimal degree was more appropriate to the instrument than 1 or 0.1 sexagesimal second. Centesimal measure is simpler for computing, especially with electronic digital computers. The Distomat was preferred to the Tellurometer for distance measurement, because it was slightly quicker at measuring a line and, being mounted on a trunnion axis, was easier to use on some of the very steep (up to 20°) lines used. The Tellurometer's main advantage of portability was not in great demand, due to the availability of helicopters. The original field observations were immediately triplicated on the return to base on a small office copying machine, run from a portable generator. The original was then filed and not used further. One copy was provided to each computer (British, Argentine and Chilean) and all computations were performed three times, with appropriate cross-checks. The Mixed Commission triangulation was observed before the invention of EDM and internal evidence suggested that a scale error up to 1/20,000 could be expected. Such an error is normal in chains of triangulation of this type and, provided a suitable overall adjustment is made, does not affect the usefulness of results. However, EDM measures distances to better than 1/100,000, so that it is difficult to make EDM traverses sympathize with existing triangulation. Accordingly, the first observing task was to measure three lines of the existing triangulation by Tellurometer and Distomat to give an adjustment factor from EDM triangulation. This factor was used on all measured lengths to ensure that the new EDM traverses fitted the existing triangulation. The computations were completed as far as the rectangular co-ordinates and elevations of the BPs before the Mission left Palena, and these results were issued there as provisional co-ordinates. On the return of the Mission to England the computations were repeated at the Geodetic Office, Survey Production Centre, RE, using its ICT Pegasus computer. This was a more rigorous solution, with no approximations for plane computation, using a variation of co-ordinates, least square, adjustment to control. The results agreed with the field computations within the expected limits and are now the "legal" values of the BPs. All figures closed to well within third-order tolerances, the largest triangular misclosure being 4 in and the worst traverse misclosure 1/44,000.[11]

Simultaneously with the other work, three pairs of topographers ground checked the 1/50,000 map for completeness and accuracy of depiction of the detail, for 2 kilometres on each side of the boundary. There were very few errors of interpretation on the map, but the topographers were able to complete the streams where they could not be seen on the air photographs beneath the tree cover, and to adjust track classifications. Each pair was given a zone, where they camped, and which they covered mainly on horseback, but with occasional helicopter assistance. The topographers were not very familiar with this type of work and close supervision by an experienced surveyor was needed. Unfortunately this proved difficult because of the remoteness of the topographers and also because all the Mission members and the

[11] The technical survey aspects of the work of the Demarcation Mission are to be the subject of a paper to the Photogrammetric Society.

experienced surveyors from the two Parties were busy on other tasks. The presence of helicopters was a disadvantage, as the topographers tended to sit in their camp in the hope that a helicopter would arrive with time to spare to help them. Usually when the weather was good enough for flying the helicopters were busy elsewhere. The work proceeded slowly, but all the areas of importance were completed.

All the administrative arrangements were made by the two Parties, who both made extraordinary efforts to smooth the path of the Mission by providing every possible assistance. Daily evening meetings were held to review progress and plan future operations. The Demarcation Mission had only to allot a task to one or other Party for it to be carried out most efficiently. The Mission was extremely well cared for throughout its time in South America. In Palena, Chile placed a small hotel entirely at our disposal and provided a house as offices for ourselves, the computers, topographers, draughtsman and stores. The liaison officers and surveyors lived in the school and various houses, eating in a central Mess. For one week the Mission moved to the south shore of Lago General Paz, in order to reduce helicopter travelling time in the southern section. Here, at very short notice, Argentina produced good accommodation in a Gendarmaria post and a timber factory. We were very well received by the resident population on both sides of the frontier, from whom we received considerable assistance and hospitality. The liaison officers and their staffs, several of whom were with the Field Mission, proved to be as good companions as in the previous year. They worked extremely hard, often in bad conditions, and I very much appreciate the support they gave me.

The Demarcation Mission completed the field work on 9 February 1967 and left Palena on 11 February 1967. Various documents were prepared in Buenos Aires for copying by the Parties and after liaison visits there, and in Santiago, the Mission returned to England on 25 February 1967. The field work was completed in one month, for although the weather was very bad for much of the time, two fine spells enabled the task to be finished expeditiously.

DEMARCATION MISSION REPORT

The Award required the Director of Military Survey to submit a report on the work of the Demarcation Mission as soon as possible after its return. The first draft was prepared by 15 March 1967, and at this stage the various interested organizations (the Court, the Foreign Office and the Parties) expressed their opinions on the contents and distribution of the Report. Successive drafts were discussed and the supporting documents were prepared and checked. Meanwhile Fairey Surveys made a revised edition of the map, incorporating the BPs, the line of the boundary and the topographer's corrections. Eventually it was decided that the Report (copy of this report is now held in the RE Corps Library) should be produced in two parts, Part I of 94 pages and 3 maps, and Part II of 550 pages and 11 traces. This was a much bigger project than originally visualized. Listed below are the main contents of the Report, as an indication of the large amount of documentation that is necessary in boundary demarcation.

PART I—General distribution (155 copies). Printed by lithography.

Main Report including:

relevant portions of the Award and Instructions;
a description of the area;
the tasks undertaken;
the techniques used;
administration.

Annexes including:

a 1/250,000 diagrammatic map of the area:
the revised 1/50,000 map;

a triangulation diagram;
a list of personnel engaged;
a diary of the progress of the work;
a description of the boundary;
notes on the selection of each BP site;
a minute of erection for each BP;
a description form for each BP (including a half-tone photograph);
a copy of the Technical Instructions;
details of the existing triangulation;
a report on the field computations;
a report on the final computations;
the final list of co-ordinates of the BPs.

PART II—Limited Distribution (ten copies). Mainly xerox copies of originals.

Annexes including:

the original observation sheets;
the abstracts of observations;
the field computations;
the final computations;
the original map-completion field traces;
the compiled addition and deletion traces;
marked air photographs of BPs and new trigonometrical points;
annotated panoramic photographs from BPs and new trigonometrical points;
reports on three detailed surveys in areas of special difficulty.

On 29 June 1967 the report was submitted to the British Government,[12] who passed it to the Court of Arbitration. On 18 July 1967 the Court approved the demarcation and expressed its opinion that the Award had been executed. Copies of the report were passed to the Parties. This, as far as I was concerned, marked the end of a most enjoyable and interesting task.

FURTHER READING

A great deal has been written about the esoteric political and geographical aspects of frontiers, and there are reports in various journals on the activities of individual boundary commissions, but there are very few practical guides to boundary delimitation and demarcation. By far the most useful book is *Boundary Making, a Handbook for Statesmen, Treaty Editors and Boundary Commissioners*, by Stephen B. Jones, published by the Carnegie Endowment, Washington, 1945. This gives practical advice, with abundant examples, on all aspects of boundary work and has a useful bibliography.[13] A useful summary with a very good, though somewhat outdated, bibliography is *The Demarcation of International Frontiers*, by Colonel H. St J. L. Winterbotham, a paper to the Empire Survey Conference, 1928.[14] For more detailed suggestions on demarcation, *Boundary Commissions*, by Major E. H. M. Clifford, RE, in the *RE Journal* of September 1937 is recommended. A good example of an account of the work of a Boundary Commission is *The British Somaliland—Ethiopia Boundary*, by Lieut.-Colonel E. H. M. Clifford, RE, in the *Geographical Journal* of April 1936.

(The photographs were taken by Senor A. Fernandez (Chile) and the map was drawn by Mr J. F. Offley (Survey Production Centre)).

[12] "Report by the Director of Military Survey to the Government of the United Kingdom on the work of the Demarcation Mission appointed to carry out the demarcation of the course of the Argentine-Chile Boundary in the sector between Boundary Posts 16 and 17", Ministry of Defence, June 1967.

[13] On page 175 is the statement: "Improvements in the helicopter may greatly expedite ground work in difficult terrain, permitting the quick movement of men and instruments, and perhaps of material for monuments, to points difficult to reach by surface transportation." This is remarkable foresight for someone writing in 1945.

[14] The section on "Imperial Defence" would be considered tactless today, but it is mild compared with earlier views which regarded frontier settlement as a branch of imperial policy. The most extreme and interesting example of this approach is *Frontiers*, by Lord Curzon, the Romanes Lecture of 1907.

Photo 1. The Field Mission starting a tour of California, the main settled area in the disputed zone. Left to right (on horses): Brigadier Papworth, Mr Kirwan, Major Rushworth, Mr Chapman (interpreter).

Photo 2. The Field Mission studying the northern part of California Valley from the source of the Rio Encuentro as claimed by Argentina. The burnt tree stumps can be seen over the whole valley.

The Argentine Chile Frontier Case, 1965-7 1 & 2

Photo 3. The Demarcation Mission Reconnaissance Party siting BPs where the boundary crosses the Rio Engano/Salto. Left to right: Staff Sergeant Browning, Commandante Ayala (Chile), Lieut-Colonel Marini (Argentina), Major Rushworth.

Photo 4. The author siting BP VII-2J on the straight line between BP VII-2H, in the picture, and BP VII-2K on the far side of the Salto/Engano valley. A "handie-talkie" radio is being used to direct Staff Sergeant Browning to the correct location.

Photo 5. Observations at BP VII-2G, on the northern slopes of the Cerro da la Virgen, with a Wild Distomat by Senor Soria (Argentina) and Major Cepeda (Chile).

Photo 6. BP VII-2H, looking north up California Valley.